Effect of stiffness factor on spinal dynamic stabilization device through patient type specific modeling

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Introduction

The cadaver tests and finite element analysis (FEA) reported Dynamic Stabilization procedure decreased disc pressure to adjacent levels and reduced the development of transition syndrome.[1,2] However, these researches were conducted with asymptomatic cadaver or in normal condition FE model and designed on comparison of devices without consideration of actual patient characteristics.[3,4] Depending on symptoms, devices certainly do make differences on patients, flexibility of devices surely affects spinal motion and different stiffness makes different spinal kinematics. Therefore, this study is designed with influence of patient information and consideration of stiffness effect.

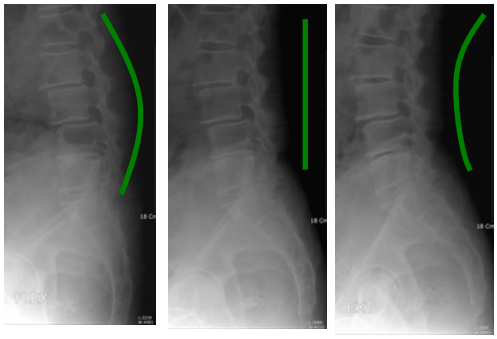

Figure 1: Radiographic images of Flexion, Neutral Standing and Extension

Method

In this study, a 3D model of the L2 ~ L4 lumbar spine was created from Computed Tomography (CT) images. To obtain patient information, geometry and range of motion (ROM), radiographic images of six pre-operated patients with spinal fusion surgery due to L3/4 disc degeneration and spondylolisthesis were analyzed at flexion, extension and neutral standing as figure 1 shown. The patients were divided to two groups; hypo-mobility and hyper-mobility. Then, patient specific FE models which followed the analyzed geometry and ROM of the two patient groups were built and dynamic stabilization device was implanted within the models. As stiffness of the device changed, normal flexion and extension were simulated. ROM and magnitude of maximum Von Mises stress were measured with each changes of stiffness.

Result

As stiffness increased, ROM and stress of both models decreased at the disease level and they increased at the adjacent levels as figure 2 shown. However, two models had different initial points and the hyper-mobility model only showed existence of efficient stiffness which made patient normal, asymptomatic performance. Also, stiffness saturation was shown as ROM and stress did not make much difference although stiffness increased.

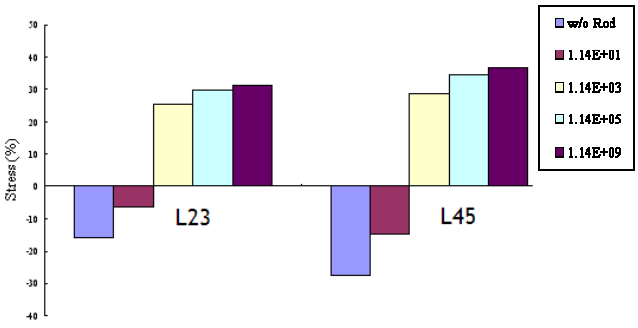

Figure 2: Stress of the Hyper-mobility for Flexion

Discussion

The finding of the study shows significant influence of stiffness effect and importance of patient information. Also, it represents different effectiveness of dynamic stabilization depending on patient symptoms.

Reference

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4 Nockels (2005) Spine (15) S68-72